(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 107 799 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
14.05.2014 Bulletin 2014/20

(51) Int Cl.:
H04N 5/33 *(2006.01)* ***H04N 17/00*** *(2006.01)*

(21) Application number: **09155228.1**

(22) Date of filing: **16.03.2009**

(54) **An IR camera and a method for processing information in images**

IR Kamera und Verfahren zum Verarbeiten von Information in Bildern

Caméra infrarouge et méthode de traîtement des informations dans les images

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR

(30) Priority: **02.04.2008 US 60891**

(43) Date of publication of application:
07.10.2009 Bulletin 2009/41

(73) Proprietor: **Flir Systems AB**
187 15 TÄBY (SE)

(72) Inventor: **Strandemar, Katrin**
762 94 Rimbo (SE)

(74) Representative: **Kitzler, Michael et al**
IPQ IP Specialists AB
Docketing
Box 42
683 21 Hagfors (SE)

(56) References cited:
WO-A-00/23843 **US-A1- 2006 289 772**

- **KIRK JOHNSON, TOM MCMANUS, ROGER SCHMIDT: THERMOSENSE XXVIII, PROC. SPIE, vol. 6205, 17 April 2006 (2006-04-17), XP002537757 Orlando, FL, USA**
- **DWYER D J ET AL: "Real-time implementation of image alignment and fusion" PROCEEDINGS OF THE SPIE - THE INTERNATIONAL SOCIETY FOR OPTICAL ENGINEERING, SPIE, PO BOX 10 BELLINGHAM WA 98227-0010 USA, vol. 5612, no. 1, 25 October 2004 (2004-10-25), pages 85-93, XP003023852 ISSN: 0277-786X**

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 2 107 799 B1

Description

Technical Field

[0001] The present invention relates to detection of laser light in an infrared image captured by an IR camera.

Background

[0002] In various applications there is a growing need to determine accurately the position of hot and cold spots that will appear in an infrared image.

[0003] It is not always easy to map a visual picture to a thermal image taken by an infrared camera of the same object. Interesting characteristics that appear in the visual spectrum may be invisible in the infrared spectrum and vice versa.

[0004] For example, when viewing a construction wall comprising a pipe carrying heat, as is common in municipal heating networks, an essential construction detail, that is only visible in the visual spectrum of the radiation, as well as a heat leakage which is only visible in the infrared spectrum of the radiation, could be relevant information during a maintenance assignment.

[0005] Most IR cameras are equipped with a laser pointer, but the reflected laser light is detected only in the visual spectrum of the radiation and not in the infrared spectrum of the radiation. Hence, the laser point generated on the object by the laser pointer will be visible in the visual image but not in the IR image. It is therefore desirable to determine accurately the positions of hot and cold areas shown in the IR image by detecting reflected laser light. Moreover, current laser devices operating in the infrared spectrum of the radiation have too high energy and may also be harmful to objects or people in the vicinity.

[0006] Document 2006/289772 (D1) discloses an IR camera with a visible light camera module and an infrared camera module and a method for displaying IR and/or visible light images. The camera may also comprise a laser pointer to help identify locations of points-of-interest in the images. The camera is calibrated to identify the location of the laser spot in the infrared image using parallax calibration data as a function of the infrared focus distance, i.e. the focus position of the infrared lens.

Summary

[0007] It is an object of the present invention to provide a method and an apparatus to detect laser light and indicate said laser light in an IR image.

[0008] The invention relates to a method for processing information in images comprising the steps of receiving emitted and reflected radiation from an object, generating a visual image and an infrared image based on the received radiation and generating a laser spot on the object by means of a laser pointing device. The method is further defined according to the steps in claims 1-7.

[0009] The invention also relates to an IR camera for processing information in images comprising a first imaging part for capturing IR image data of an object, a second imaging part for capturing visible light data of the object, a laser pointer for providing a laser spot on the object, and a processor for generating an IR image based on the IR image data and a visual image based on the visible light data;

a memory comprising means for storing the at least two different images and determined at least one calibration and fusion coefficient;

[0010] The IR camera is further defined according to the features of claims 8-14.

Brief Description of the Drawings

[0011]

Fig. 1 is a schematic view of an IR camera.

Fig. 2 shows a schematic view of an arrangement of the three optical systems of the inventive IR camera.

Fig. 3 is a flow chart showing how the position of the laser point in a visual image as a function of the distance to the object may be determined during calibration.

Fig. 4 shows a schematic view of a calibration station.

Fig. 5 is a flow chart of how the position of the laser point may be indicated in the IR image.

Detailed Description

[0012] Figure 1 shows a schematic view of an IR camera **10** according to an embodiment of the invention. The IR camera **10** comprises an assembly **12** holding three optical systems which typically comprise one or more lenses and control devices for adjusting the lenses to capture the incoming radiation from an object.

[0013] The assembly **12** comprises a visual optical system **14** which comprises a visual sensor array **16** for the visual spectrum of the radiation, and an infrared optical system **18** comprising an infrared sensor array **20** for the infrared spectrum of the radiation. The final optical system comprised in the assembly **12** generates a laser beam and this system is known as a laser point system **22.** The emitted laser beam is reflected on the object and is typically visible by the naked eye as a red spot (e.g. semiconductor AIGaInP Diode Laser ImW/635 nm).

[0014] The reflected light of the laser beam, as well as other emitted radiation from the object, is captured by the sensor arrays **16, 20** and turned into signals which are processed by a processing device **13** to produce both a visual image and an infrared image. The processing device **13** may also produce of the visual and infrared images typically a fused or blended image. Other possible data that may be displayed to a user of the IR camera may also be processed. The IR camera **10** comprises a memory storage **15** for storing the data registered or processed by the IR camera **10** as well as a plurality of control devices **19** (e.g. a display, thumb-joystick and record/push-buttons) and at least one interface medium **21** (e.g. wired or wireless connections, IRDA, Bluetooth, USB, Fire-Wire, etc).

[0015] Since the sensor elements of the visual sensor array **16** are sensitive to the wavelength of the laser light, the reflected light of the laser beam may be detected in the visual image by its picture elements, i.e. pixels. The picture elements may, for example be CCDs (charge-coupled devices). This is not the case in the infrared sensor array **20**.

[0016] Figure 2 illustrates the field of view of the visual optical system **14** of the IR camera **10** in fig. 1, represented as an angle φ and the field of view of the infrared optical system 18 of the IR camera **10** in fig. **1**, represented as an angle θ. The optical axes of both the visual optical system **14** and the infrared optical system **18** are shown as dashed lines OA1 and OA2, respectively. The laser beam is represented as a solid line L. As can be seen in fig. 2 the laser beam L is emitted at a distance from the optical axis OA1 of the visual optical system **14** and with a certain angle α relative to the optical axis. A dotted line parallel to the optical axes OA1, OA2 is provided to illustrate the angle α. As can be seen, the distance between the point where the laser beam hits the object (i.e. a laser point LP) and a fixed point FP in the field of view varies with the distance z between the IR camera and the object. The fixed point FP in the field of view is typically indicated by the bisector of the angle φ, i.e. where the optical axis of the visual optical system **14** hits the object.

[0017] At the first distance Z1 from the object, the distance between the laser point LP and the fixed point FP is a first object distance d1. At the second distance z2 from the object, the distance between the laser point LP and the fixed point FP is a second object distance d2.

[0018] Because of the parallax between the three optical systems the laser point LP will appear in different positions relative to the distinct field of views of each optical system.

[0019] The relationship between a given distance z from the IR camera to the object and the distance d between the laser point LP and a predetermined point in the visual image, and in the IR image, respectively (i.e. the projections of the field of views comprising the reflected laser point onto the sensor arrays and where the processing device **13** generates the visual and infrared images) is given by equation (1):

$$d = c1/z + c2 \qquad (1)$$

Hence, the distance z can be obtained as

$$z = c1/(d-c2) \qquad (2)$$

[0020] Here c1 and c2 are constants to be determined, d is the distance between the laser point LP and the fixed point FP in the visual image, and z is the distance between the IR camera and the object. The constant c1 is dependent on the distance between the laser point system **22** and the visual optical system **14** and the constant c2 is dependent on the angle α between their optical axes.

[0021] Hence, having determined c1 and c2 during calibration, the distance d between the laser point LP and the fixed point FP in the visual image can be used to determine the distance z between the IR camera and the imaged object during normal operation. This distance z will be the focusing distance if the laser point system **22** is pointing at the object that should be in focus. Hence, this information can be used for exact focusing of the IR camera.

[0022] Typically the equations (1) and (2) above are calculated separately for the x axis and the y axis of the visual image, that is, for the displacement in the horizontal and vertical direction, respectively.

[0023] The displacement d1, d2 of the laser point LP in the visual image as a function of the distance from the IR camera to the object can be determined empirically for example during calibration of the IR camera **10,** in the following way as illustrated in Figure 3:

Step S31: Produce a first visual image of an object at a first known distance z1 from the IR camera. The distance z1 is shown in fig. 2 and in fig. 4.
Step S32: Determine the position of the laser point in the first visual image.
Step S33: Produce a second visual image of an object at a second known distance z2 from the IR camera. The distance z2 is shown in fig. 2 and in fig. 4, typically relative to a predetermined point in the image.
Step S34: Determine the position of the laser point in the second visual image.
Step S35: For each of the positions of the laser point, determined in steps S32 and S34, determine the relationship between the displacement in the visual image and the distance between the IR camera and the object.

[0024] The positions of the laser point may also be used to estimate an equation or a curve for the displacement as a function of the distance to the object. This equation, or curve, is stored in a memory in the IR camera, for example, the memory storage **15,** and can be used to determine the displacement needed of the laser point in the IR image in dependence of the distance z to the object as will be discussed in connection with Figures 4 and 5.

[0025] Fig. 4 shows a calibration station **24** where the calibration coefficients needed to perform fusion between the IR image and the visual image also are determined. This is typically done for every individual produced infrared camera **10** at the calibration station **24.** How to determine fusion parameters is known in the art, but will be briefly discussed in the following. The infrared camera **10** is rigged and aligned towards a grid screen **26** (which background color is white), where the distance z between the infrared camera **10** and the grid screen **26** is known. The distance can also be regulated. At least one of the black painted grid points also comprises at least one fixed point which is heated (i.e. a temperature fixed point TFP). The laser point LP is reflected against the screen and detected by the (two-dimensional) visual sensor array **16** of the IR camera **10** in fig. 1, which will sense at least two pixel coordinates representing the laser point LP. At the same time the at least one temperature fixed point TFP, preferably in the center of the screen, will be detected by both the pixel coordinates in the two dimensional visual sensor array **16** of the IR camera **10** in fig. 1 since it is painted black, and the infrared sensor array **20** of the IR camera **10** in fig. 1, since it is heated.

[0026] A first visual image V and a first infrared image IR is taken at a known distance z1. The laser point LP will be represented by the coordinates (tx_{VLP}, ty_{VLP}) in the visual image. The at least one temperature fixed point TFP will be represented by the coordinates (tx_{VTFP}, ty_{VTFP}) and (tx_{irTFP}, ty_{irTFP}) in the first visual and infrared image, respectively.

[0027] The procedure is repeated at another known distance z2 where a second visual image V' and a second infrared image IR' are taken, which will give a laser point LP' with coordinates ($tx_{VLP'}$, $ty_{VLP'}$) in the visual image. The at least one temperature fixed point TFP' will be represented by the coordinates ($tx_{VTFP'}$, $ty_{VTFP'}$) and ($tx_{irTFP'}$, $ty_{irTFP'}$) in the second visual and infrared image, respectively.

[0028] By the repeated procedures both the relation between the different coordinates in the visual and infrared images and the displacement of the laser point between the first and second image occasion are established.

[0029] This results in a total of four images i.e. measurements comprising two visual and two infrared images, which will give rise to an equation system where the coefficients are determined, since there now exists two equations for each coordinate. The coefficients in the equations for the infrared coordinates are determined in a way as previously described. The equations and procedures are similar to the first case:

$$Tx_{ir}=d1/z+d2 \tag{3}$$

$$Ty_{ir}=d3/z+d4 \tag{4}$$

[0030] And hence the calibration coefficients (d1, d2, d3 and d4), also called the fusion parameters, are determined.

[0031] The fusion parameters are then used to determine the relative displacement of the visual image and the IR image in the x and y direction that is needed to align the images. These parameters can also be used to determine the displacement of the laser point in the IR image based on its position in the visual image.

[0032] Figure 5 is a flow chart of how to align the IR images and visual images after calibration, during normal use of the IR camera.

[0033] Step S51: emit a laser beam from the laser point system **22** of the IR camera **10** towards an object to generate a reflected laser point on the object. Step S52: capture a visual image of the object, including the laser point, using the visual optical system **14** of the IR camera **10**. Step S53: determine the distance d between the laser point and a predetermined point in the image, for example, the centre of the image. Step S54: use the distance d determined in step S53 to determine the distance z between the IR camera **10** and the object. Step S55: use the distance z to determine the position of the laser point in the IR image based on the fusion parameters. Step S56: Present the laser point in the IR image. Preferably, the pixels corresponding to the coordinates determined for the laser point in the IR image are highlighted by GUI-symbol technique (GUI=Graphical User Interface) hence showing the laser point correctly aligned in the infrared image for the user.

[0034] As the skilled person will realize steps S53 and S54 can be omitted. Instead, equations can be developed based on equations (1) - (4) above, that will permit calculation of the position of the laser point in the IR image in step S54 directly from the position in the visual image. This means that in step S54 the corresponding infrared coordinates Tx_{ir} and Ty_{ir} in the infrared image, may be calculated by the processing device **13** based on the information of the position of the laser point in the visual image.

[0035] Before the images are presented they must be processed to enable the display. Especially if the visual and IR images are to be fused, or blended, they must be aligned. This is well known to the skilled person but will be outlined below. Since the field of view for the visual optical system **14** is approximately twice the angle of the field of view for the infrared optical system **18** it will normally completely cover the area of the object viewed by the infrared optical system **18**. Only the visual area overlapping the infrared area is taken into account, and a large amount of the visual information is therefore deleted. The laser point system **22** is placed in the vicinity of the infrared optical system 18, which is advantageous. The reflected laser point will always be in the area of the object which the infrared optical system covers, and will hence always be detected by the visual optical system **14**.

[0036] The size of a sensing element is related to the wavelength of the radiation it detects, and an infrared sensing element is typically at least three times a corresponding element for the visual wavelength. This makes the infrared sensor array **20** of a lower resolution, since it has larger sensor elements or pixels than the visual sensor array **16**, and the size of a pixel in the infrared sensor array **20** could comprise at least three pixels of the visual sensor array **16**, normally more.

[0037] The visual information is appropriately cut and aligned with corresponding information in the infrared image in a suitable manner by the fusion parameter where both the field of view and the different array resolutions must be taken into account when aligning and scaling the images.

Claims

1. A method for determining the relative displacement between a visual image and an infrared (IR) image obtained by means of an IR camera (10), the method comprising the steps of:

   generating a laser spot on an object, wherein the laser spot is generated by a laser point system (22);
   receiving emitted and reflected radiation from the object, wherein the received radiation includes radiation from the laser spot;
   generating a visual image from a visual sensor (16) and an IR image from an IR sensor (20), wherein both images are based on the received radiation;
   detecting visual image coordinates of the laser spot in the visual image;
   determining the distance (d) between the visual image coordinates of the laser spot and a predetermined point in the visual image;
   determining a distance (z) between the IR camera (10) and the object based on the distance (d) between the visual image coordinates of the laser spot and a predetermined point in the visual image; and
   determining the IR image coordinates of the laser spot in the IR image based on the distance (z) between the IR camera (10) and the object and at least one displacement parameter (d1-d4) related to the displacement between the visual image and the IR image;
   wherein the distance (z) between the IR camera (10) and the object is determined based on a first constant (c1) related to the distance between the laser pointer and the visual sensor and a second constant (c2) related to the angle (α) between the optical axis of the laser pointer and the optical axis of the visual sensor; and
   determining the IR image coordinates of the laser spot in the IR image, using the relative displacement between the visual image and the IR image, and highlighting the laser spot image in the infrared image.

2. A method according to claim 1, wherein the at least one displacement parameter (d1, d2, d3, d4) is determined during calibration of the IR camera.

3. A method according to any of the previous claims, wherein the predetermined point in the visual image is the center

of the visual image.

4. A method according to any of the previous claims, wherein the at least one displacement parameter (d1-d4) is a fusion parameter.

5. A method according to any of the previous claims, further comprising the step of highlighting the IR image coordinates of the laser spot in the IR image.

6. A method according to any of the previous claims, further comprising the step of creating a blended image based on at least part of the visual image and at least part of the IR image, wherein the at least part of the visual image and at least part of the IR image are aligned using the determined relative displacement of the visual image and the IR image in the x and y direction.

7. A method according to the preceding claim, further comprising the step of highlighting the IR image coordinates of the laser spot in the blended image.

8. An IR camera (10) for determining the relative displacement between a visual image and an infrared (IR) image comprising:

   a laser point system (22) for providing a laser spot on an object;
   an IR sensor (20) for capturing IR image data relating to the object;
   a visual sensor (16) for capturing visible light data relating to the object;
   a processor (13) for generating an IR image based on the IR image data captured by the IR sensor (20) and a visual image based on the visible light data captured by the visual sensor (16);
   a memory (15) comprising means for storing the at least two different images and a displacement parameter;
   the processor (13) is arranged to:

      detect visual image coordinates of the laser spot in the visual image;
      determine the distance (d) between the visual image coordinates of the laser spot and a predetermined point in the visual image;
      determine a distance (z) between the IR camera (10) and the object based on the distance (d) between the visual image coordinates of the laser spot and a predetermined point in the visual image; and

   determine the relative displacement of the visual image and the IR image in the x and y direction based on the distance (z) between the IR camera (10) and the object and at least one displacement parameter (d1-d4) related to the displacement between the visual image and the IR image,
   wherein the processor (13) is arranged to determine the distance (z) between the IR camera and the object based on a first constant (c1) related to the distance between the laser pointer and the visual sensor and a second constant (c2) related to the angle (α) between the optical axis of the laser pointer and the optical axis of the visual sensor; and the processor (13) is further arranged to determine and highlight the IR image coordinates of the laser spot in the IR image, using the displacement between the visual image and the IR image.

9. A camera according to claim 8, wherein the at least one displacement parameter (d1, d2, d3, d4) is determined during calibration of the IR camera.

10. A camera according to any of claims 8 or 9, wherein the predetermined point in the visual image is the center of the visual image.

11. A camera according to any of claims 8-10, wherein the at least one displacement parameter (d1-d4) is a fusion parameter.

12. A camera according to any claims 8-11, wherein the processor (13) is further arranged to highlight the IR image coordinates of the laser spot in the IR image.

13. A camera according to any of claims 8-12, wherein the processor (13) is further arranged to create a blended image based on at least part of the visual image and at least part of the IR image, wherein the at least part of the visual image and at least part of the IR image are aligned using the determined relative displacement of the visual image and the IR image in the x and y direction.

14. A camera according to the preceding claim, wherein the processor (13) is further arranged to highlight the IR image coordinates of the laser spot in the blended image.

Patentansprüche

1. Verfahren zum Bestimmen des relativen Versatzes zwischen einem visuellen Bild und einem Infrarot- (IR) Bild, das mittels einer IR-Kamera (10) erhalten wurde, wobei das Verfahren die Schritte umfasst:

Erzeugen eines Laserpunkts auf einem Objekt, wobei der Laserpunkt von einem Laserpointersystem (22) erzeugt wird;
Empfangen abgestrahlter und reflektierter Strahlung von dem Objekt, wobei die empfangene Strahlung eine Strahlung von dem Laserpunkt einschließt;
Erzeugen eines visuellen Bildes von einem visuellen Sensor (16) und eines IR-Bildes von einem IR-Sensor (20), wobei beide Bilder auf der empfangenen Strahlung basieren;
Erfassen visueller Bildkoordinaten des Laserpunkts in dem visuellen Bild;
Bestimmen der Entfernung (d) zwischen den visuellen Bildkoordinaten des Laserpunkts und einem vorbestimmten Punkt in dem visuellen Bild;
Bestimmen einer Entfernung (z) zwischen der IR-Kamera (10) und dem Objekt, basierend auf der Entfernung (d) zwischen den visuellen Bildkoordinaten des Laserpunkts und einem vorbestimmten Punkt in dem visuellen Bild; und
Bestimmen der IR-Bildkoordinaten des Laserpunkts in dem IR-Bild, basierend auf der Entfernung (z) zwischen der IR-Kamera (10) und dem Objekt und mindestens einem Versatzparameter (d1-d4), der sich auf den Versatz zwischen dem visuellen Bild und dem IR-Bild bezieht;
wobei die Entfernung (z) zwischen der IR-Kamera (10) und dem Objekt basierend auf einer ersten Konstante (c1), die sich auf die Entfernung zwischen dem Laserpointer und dem visuellen Sensor bezieht, und einer zweiten Konstante (c2) bestimmt wird, die sich auf den Winkel (α) zwischen der optischen Achse des Laserpointers und der optischen Achse des visuellen Sensors bezieht; und
Bestimmen der IR-Bildkoordinaten des Laserpunkts in dem IR-Bild unter Verwendung des relativen Versatzes zwischen dem visuellen Bild und dem IR-Bild; und
Hervorheben des Laserpunktbilds in dem Infrarotbild.

2. Verfahren nach Anspruch 1, wobei der mindestens eine Versatzparameter (d1, d2, d3, d4) während der Kalibrierung der IR-Kamera bestimmt wird.

3. Verfahren nach einem der vorhergehenden Ansprüche, wobei der vorbestimmte Punkt in dem visuellen Bild die Mitte des visuellen Bilds ist.

4. Verfahren nach einem der vorhergehenden Ansprüche, wobei der mindestens eine Versatzparameter (d1, d2, d3, d4) ein Fusionsparameter ist.

5. Verfahren nach einem der vorhergehenden Ansprüche, weiter umfassend den Schritt des Hervorhebens der IR-Bildkoordinaten des Laserpunkts in dem IR-Bild.

6. Verfahren nach einem der vorhergehenden Ansprüche, weiter umfassend den Schritt des Erzeugens eines Mischbilds, basierend auf mindestens einem Teil des visuellen Bilds und mindestens einem Teil des IR-Bilds, wobei der mindestens eine Teil des visuellen Bilds und der mindestens eine Teil des IR-Bilds unter Verwendung des bestimmten relativen Versatzes des visuellen Bilds und des IR-Bilds in der x- und y-Richtung ausgerichtet werden.

7. Verfahren nach einem der vorhergehenden Ansprüche, weiter umfassend den Schritt des Hervorhebens der IR-Bildkoordinaten des Laserpunkts in dem Mischbild.

8. IR-Kamera (10) zum Bestimmen des relativen Versatzes zwischen einem visuellen Bild und einem Infrarot- (IR) Bild, umfassend:

ein Laserpointersystem (22), um einen Laserpunkt auf einem Objekt bereitzustellen;
einen IR-Sensor (20) zum Erfassen von IR-Bilddaten, die sich auf das Objekt beziehen;
einen visuellen Sensor (16) zum Erfassen von Daten sichtbaren Lichts, die sich auf das Objekt beziehen;

einen Prozessor (13) zum Erzeugen eines IR-Bilds, basierend auf den IR-Bilddaten, die von dem IR-Sensor (20) erfasst wurden, und eines visuellen Bilds, basierend auf den Daten sichtbaren Lichts, die von dem visuellen Sensor (16) erfasst wurden;
einen Speicher (15), umfassend Mittel zum Speichern der mindestens zwei verschiedenen Bilder und eines Versatzparameters;
wobei der Prozessor (13) eingerichtet ist zum:

Erfassen visueller Bildkoordinaten des Laserpunkts in dem visuellen Bild;
Bestimmen der Entfernung (d) zwischen den visuellen Bildkoordinaten des Laserpunkts und einem vorbestimmten Punkt in dem visuellen Bild;
Bestimmen einer Entfernung (z) zwischen der IR-Kamera (10) und dem Objekt basierend auf der Entfernung (d) zwischen den visuellen Bildkoordinaten des Laserpunkts und einem vorbestimmten Punkt in dem visuellen Bild; und
Bestimmen des relativen Versatzes des visuellen Bilds und des IR-Bilds in der x- und y-Richtung basierend auf der Entfernung (z) zwischen der IR-Kamera (10) und dem Objekt und mindesten einem Versatzparameter (d1-d4), der sich auf den Versatz zwischen dem visuellen Bild und dem IR-Bild bezieht;
wobei der Prozessor (13) eingerichtet ist, die Entfernung (z) zwischen der IR-Kamera und dem Objekt basierend auf einer ersten Konstante (c1), die sich auf die Entfernung zwischen dem Laserpointer und dem visuellen Sensor bezieht, und einer zweiten Konstante (c2) zu bestimmen, die sich auf den Winkel (α) zwischen der optischen Achse des Laserpointers und der optischen Achse des visuellen Sensors bezieht; und
wobei der Prozessor (13) weiter eingerichtet ist, IR-Bildkoordinaten des Laserpunkts in dem IR-Bild unter Verwendung des Versatzes zwischen dem visuellen Bild und dem IR-Bild zu bestimmen und hervorzuheben.

9. Kamera nach Anspruch 8, wobei der mindestens eine Versatzparameter (d1, d2, d3, d4) während der Kalibrierung der IR-Kamera bestimmt wird.

10. Kamera nach Anspruch 8 oder 9, wobei der vorbestimmte Punkt in dem visuellen Bild die Mitte des visuellen Bilds ist.

11. Kamera nach einem der Ansprüche 8-10, wobei der mindestens eine Versatzparameter (d1-d4) ein Fusionsparameter ist.

12. Kamera nach einem der Ansprüche 8-11, wobei der Prozessor (13) weiter zum Hervorheben der IR-Bildkoordinaten des Laserpunkts in dem IR-Bild eingerichtet ist.

13. Kamera nach einem der Ansprüche 8-12, wobei der Prozessor (13) weiter zum Erzeugen eines Mischbilds eingerichtet ist, basierend auf mindestens einem Teil des visuellen Bilds und mindestens einem Teil des IR-Bilds, wobei der mindestens eine Teil des visuellen Bilds und der mindestens eine Teil des IR-Bilds unter Verwendung des bestimmten relativen Versatzes des visuellen Bilds und des IR-Bilds in der x- und y-Richtung ausgerichtet werden.

14. Kamera nach einem der vorhergehenden Ansprüche, wobei der Prozessor (13) weiter zum Hervorheben der IR-Bildkoordinaten des Laserpunkts in dem Mischbild eingerichtet ist.

Revendications

1. Un procédé pour déterminer le déplacement relatif entre une image visuelle et une image infrarouge (IR) obtenue au moyen d'un appareil de prise de vues IR- (10), le procédé comprenant les étapes consistant à :

générer un point laser sur un objet, dans lequel le point laser est généré par un système (22) à point laser ;
recevoir le rayonnement émis et réfléchi par l'objet, le rayonnement reçu comprenant un rayonnement provenant du point laser ;
générer une image visuelle à partir d'un capteur optique (16) et une image infrarouge à partir d'un capteur infrarouge (20), les deux images étant basées sur le rayonnement reçu :

détecter des coordonnées d'image visuelle du point laser dans l'image visuelle ;
déterminer la distance (d) entre les coordonnées d'image visuelle du point laser et un point prédéterminé dans l'image visuelle ;

déterminer une distance (z) entre l'appareil de prise de vues IR (10) et l'objet en fonction d'une distance (d) entre les coordonnées d'image visuelle du point laser et un point prédéterminé dans l'image visuelle, et
déterminer les coordonnées d'image IR du point laser dans l'image infrarouge en fonction de la distance (z) entre l'appareil de prise de vues IR (10) et l'objet et d'au moins un paramètre de déplacement (d1 -d4) en rapport avec le déplacement entre l'image visuelle et l'image IR ;
la distance (z) entre l'appareil de prise de vues IR (10) et l'objet étant déterminée sur la base d'une première constante (c1) liée à la distance entre le pointeur laser et le capteur optique, et d'une deuxième constante (c2) liée à l'angle (α) entre l'axe optique du pointeur laser et l'axe optique du capteur optique ; et
déterminer les coordonnées d'image IR du point laser dans l'image IR, en utilisant le déplacement relatif entre l'image visuelle et l'image IR, et
mettre en évidence l'image du point laser dans l'image infrarouge.

2. Un procédé selon la revendication 1, dans lequel ledit au moins un paramètre de déplacement (d1, d2, d3, d4) est déterminée lors de l'étalonnage de l'appareil de prise de vues IR.

3. Un procédé selon l'une quelconque des revendications précédentes, dans lequel le point prédéterminé dans l'image visuelle est le centre de l'image visuelle.

4. Un procédé selon l'une quelconque des revendications précédentes, dans lequel ledit au moins un paramètre de déplacement (d1-d4) est un paramètre de fusion.

5. Un procédé selon l'une quelconque des revendications précédentes, comprenant en outre l'étape consistant à mettre en évidence les coordonnées d'image IR du point laser dans l'image IR.

6. Un procédé selon l'une quelconque des revendications précédentes, comprenant en outre l'étape consistant à créer une image fusionnée sur la base d'au moins une partie de l'image visuelle et d'au moins une partie de l'image IR, ladite au moins une partie de l'image visuelle et ladite au moins une partie de l'image IR étant alignées en utilisant le déplacement relatif déterminé de l'image visuelle et de l'image IR dans la direction x et y.

7. Un procédé selon la revendication précédente, comprenant en outre l'étape consistant à mettre en évidence les coordonnées d'image IR du point laser dans l'image fusionnée.

8. Un appareil de prise de vues IR (10) pour déterminer le déplacement relatif entre une image visuelle et une image infrarouge (IR), comprenant :

un système à point laser (22) pour fournir un point laser sur un objet ;
un capteur IR (20) pour capturer des données d'image IR relatives l'objet
un capteur optique (16) pour capturer des données de lumière visible se rapportant à l'objet ;
un processeur (13) destiné à générer une image IR sur la base des données d'image IR capturées par le capteur IR (20) et une image visuelle sur la base des données de lumière visible capturées par le capteur optique (16) ;
une mémoire (15) comprenant des moyens pour stocker lesdites au moins deux images différentes et un paramètre de déplacement ;
le processeur (13) étant agencé pour :

détecter des coordonnées d'image visuelle du point laser dans l'image visuelle ;
déterminer la distance (d) entre les coordonnées d'image visuelle du point laser et un point prédéterminé dans l'image visuelle ;
déterminer une distance (z) entre l'appareil de prise de vues IR (10) et
l'objet en fonction de la distance (d) entre les coordonnées d'image visuelle du point laser et un point prédéterminé dans l'image visuelle, et

déterminer le déplacement relatif de l'image visuelle et l'image IR dans la direction x et y sur la base d'une distance (z) entre l'appareil de prise de vues IR (10) et l'objet, et au moins un paramètre de déplacement (d1- d4) en rapport avec le déplacement entre l'image visuelle et l'image IR,
le processeur (13) étant agencé pour déterminer la distance (z) entre l'appareil de prise de vues IR et l'objet en fonction d'une première constante (c1) liée la distance entre le pointeur laser et le capteur optique et d'une deuxième constante (c2) liée à l'angle (α) entre l'axe optique du pointeur laser et l'axe optique du capteur optique ; et
le processeur (13) étant en outre agencé pour déterminer et mettre en évidence les coordonnées d'image IR du

point laser dans l'image infrarouge en utilisant le déplacement entre l'image visuelle et l'image IR.

9. Un appareil de prise de vues selon la revendication 8, dans lequel ledit au moins un paramètre de déplacement (d1, d2, d3, d4) est déterminé lors de l'étalonnage de l'appareil de prise de vues IR.

10. Un appareil de prise de vues selon l'une quelconque des revendications 8 ou 9, dans lequel le point prédéterminé dans l'image visuelle est le centre de l'image visuelle.

11. Un appareil de prise de vues selon l'une quelconque des revendications 8 à 10, dans lequel ledit au moins un paramètre de déplacement (d1-d4) est un paramètre de fusion.

12. Un appareil de prise de vues selon l'une quelconque des revendications 8 à 11, dans lequel le processeur (13) est en outre agencé pour mettre en évidence les coordonnées d'image IR du point laser dans l'image IR.

13. Un appareil de prise de vues selon l'une quelconque des revendications 8 à 12, dans lequel le processeur (13) est en outre agencé pour créer une image fusionnée sur la base d'au moins une partie de l'image visuelle et d'au moins une partie de l'image IR, ladite au moins une partie de l'image visuelle et ladite au moins une partie de l'image IR sont alignées en utilisant le déplacement relatif déterminé de l'image visuelle et de l'image IR dans la direction x et y.

14. Un appareil de prise de vues selon la revendication précédente, dans lequel le processeur (13) est en outre agencé pour mettre en évidence les coordonnées d'image IR du point laser dans l'image fusionnée.

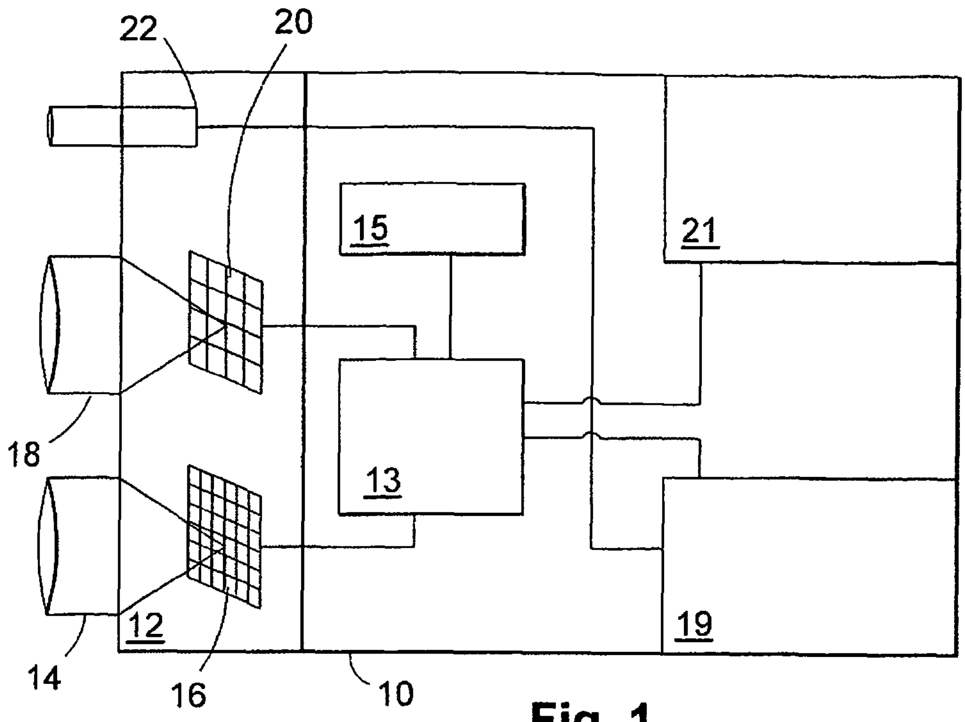
22
20
15
21
13
18
12
14
16
10
19

Fig. 1

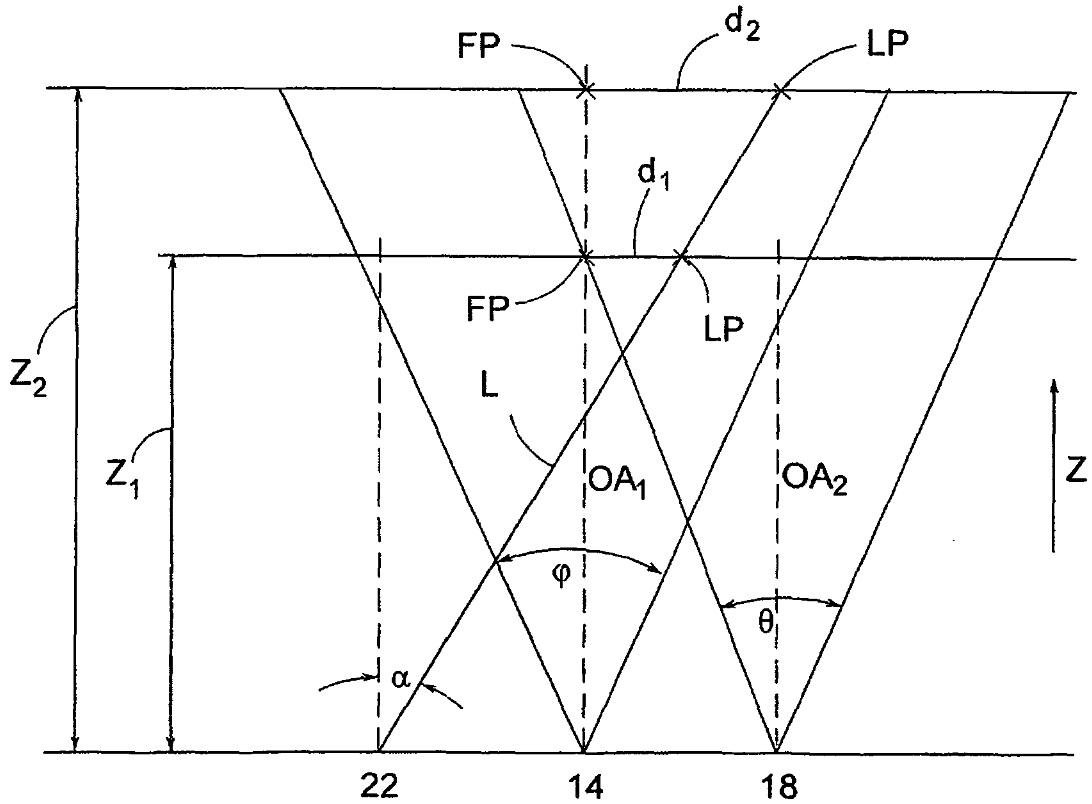
FP
d2
LP
d1
FP
LP
Z2
Z1
L
OA1
OA2
Z
φ
θ
α
22
14
18

Fig. 2

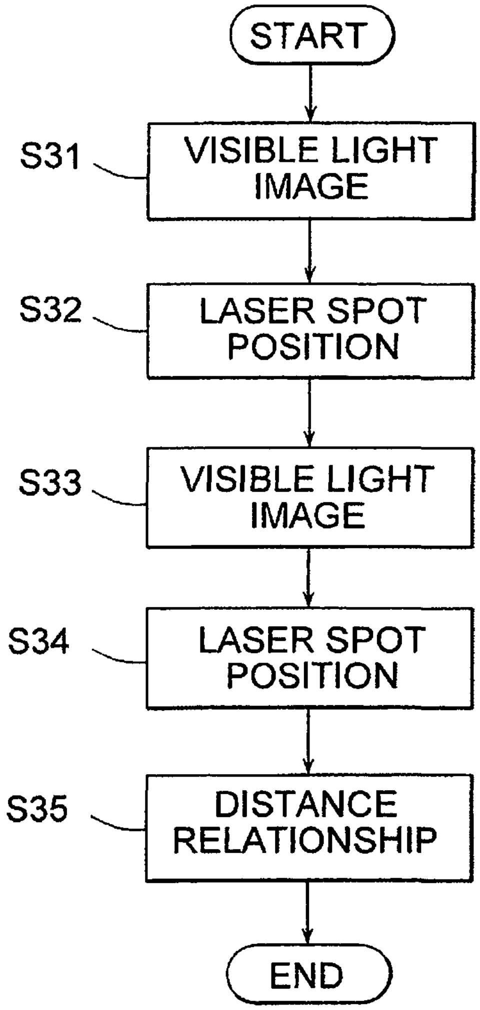
START
S31
VISIBLE LIGHT IMAGE
S32
LASER SPOT POSITION
S33
VISIBLE LIGHT IMAGE
S34
LASER SPOT POSITION
S35
DISTANCE RELATIONSHIP
END

Fig. 3

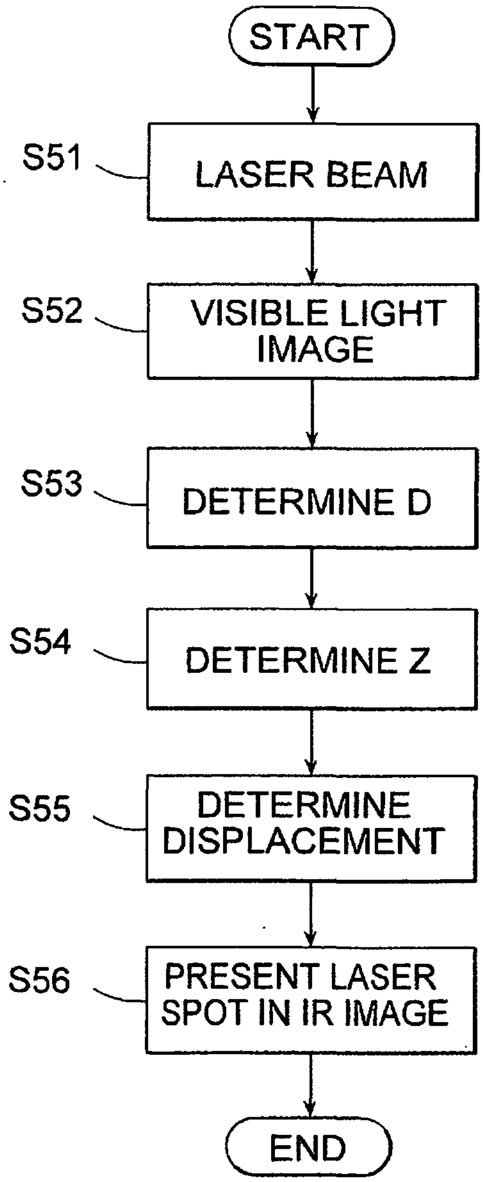
START
S51
LASER BEAM
S52
VISIBLE LIGHT IMAGE
S53
DETERMINE D
S54
DETERMINE Z
S55
DETERMINE DISPLACEMENT
S56
PRESENT LASER SPOT IN IR IMAGE
END

Fig. 5

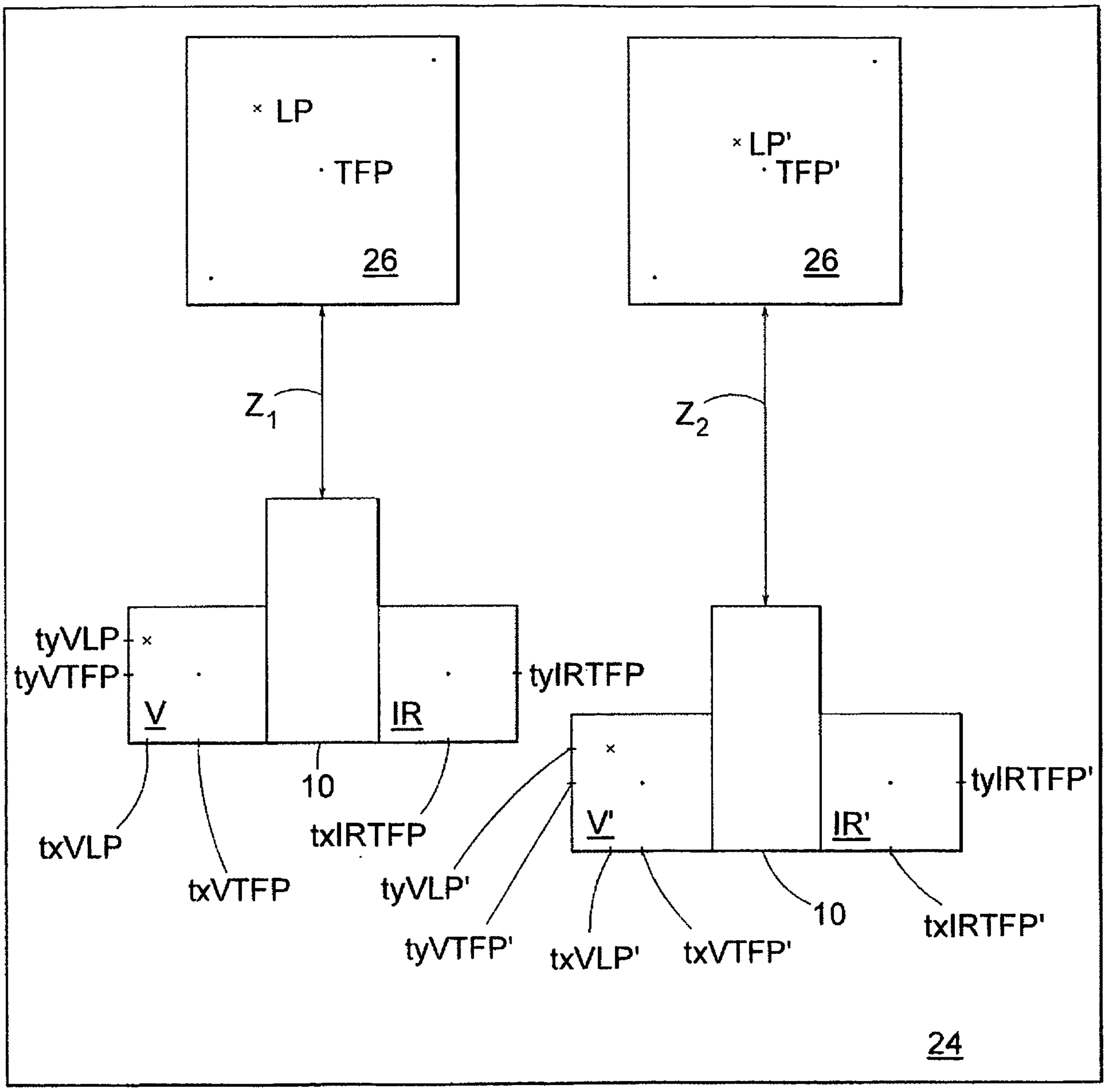
LP
TFP
26
LP'
TFP'
26
Z_1
Z_2
tyVLP
tyVTFP
V
IR
tyIRTFP
10
txVLP
txVTFP
txIRTFP
V'
IR'
tyIRTFP'
tyVLP'
tyVTFP'
txVLP'
txVTFP'
10
txIRTFP'
24

Fig. 4